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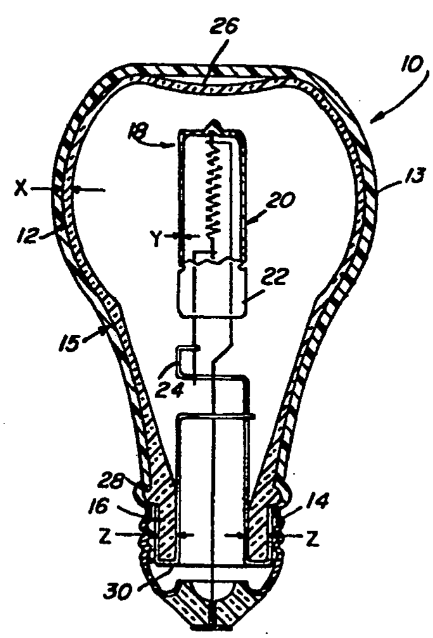
(54) **Electric lamp including a containment coating as part thereof.**

(57) An electric lamp having an envelope, a light-source capsule mounted within the envelope and a containment coating. The containment coating, which is disposed substantially over the outer envelope, has the capability of preserving the integrity of the envelope from piercing, due to shard dispersion from the light-source capsule, in the unlikely event that the capsule should fracture. One example of the coating consists of a fluoropolymer material such as a perfluoroalkoxy resin (P.F.A. Teflon). The containment coating is resistant to, and exhibits a high degree of tensile strength at, high temperatures and is substantially unaffected by ultraviolet radiation.



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ELECTRIC LAMP INCLUDING A CONTAINMENT COATING AS PART THEREOF

CROSS REFERENCE TO A CO-PENDING APPLICATION

In a co-pending Application, having United States Serial No. 469,843 ("Electric Lamp With High Outer Envelope To Inner Envelope Wall Thickness Ratio," Peter R. Gagnon), there is defined a lamp having a relatively high outer-envelope to inner-envelope wall-thickness ratio for the purpose of substantially eliminating containment failure of the lamp.

TECHNICAL FIELD

This invention relates to electric lamps and more particularly to such lamps employing light-source capsules which operate at pressures other than atmospheric. Still more particularly, this invention relates to such lamps having containment means to substantially eliminate the risk of a containment failure of the lamp.

BACKGROUND

The lighting industry is searching for a replacement for the Edison-type incandescent lamp which is currently the most popular type of lamp sold in the consumer market in the United States. Tungsten-halogen and arc discharge lamps, because of their superior performance characteristics, are being carefully considered by various lamp manufacturers as a replacement for the standard incandescent lamp. However, the remote possibility of a minor dispersion of glass shards resulting

from a fracture of the pressurized light source capsule contained within the lamp is a substantial impediment in the path of developing a feasible replacement in the consumer market. Although occurrence of such a fracture is rare, nevertheless it could present a safety hazard to a person or object in the immediate vicinity of the lamp (i.e., food preparation). A tungsten-halogen lamp or an arc discharge lap which substantially eliminates the problem of shard dispersion upon the fracture of the light source capsule would constitut an advancement in the art.

Methods have been suggested to improve the ability of tungsten-halogen and arc discharge lamps to withstand a fracture of the inner light-source capsule. In one example t shards are restricted from impacting with the outer envelope through the use of a cylindrical body disposed about the arc tube. U.S. Patent No. 4,281,274, issued July 28, 1981 to Bechard et al. In addition, the practice of applying a coati on the outside surface of a lamp envelope to hold the glass pieces together upon envelope breakage, due to an impact by a external force, is also known in the art. For example, Audes et al., in United States Patent No. 3,715,232, issued February 6, 1973, discloses the process of coating a lamp with a silicone rubber film for the above mentioned purpose.

It is believed, therefore, that an electric lamp which overcomes the several disadvantages associated with the prior art devices mentioned above would constitute a significant advancement in the art.

DISCLOSURE OF THE INVENTION

It is, therefore, a primary object of this invention to overcome the disadvantages of the prior art devices such as mentioned above.

It is another object of this invention to provide a means of containment for electric lamps which will substantially eliminate the possibility of a minor shard dispersion upon fracture of a pressurized light source capsule.

A further object of this invention is to provide means for containment which does not detract from the aesthetic appearance of lamps.

Another object of this invention is to provide means for containment which will cause little or no loss of luminous efficacy in lamps employing such means.

Still another object of this invention is to overcome a substantial impediment in the path of developing a replacement for the standard incandescent lamp in the consumer market.

In accordance with one aspect of the present invention, there is provided an electric lamp including a light-transmitting envelope, a pressurized light-source capsule mounted within the envelope and containment means for containing within the lamp fragments of glass resulting from fracture of the capsule. The containment means is disposed substantially over the envelope and is of a substantially light transmissive material. The containment means has a high degree of tensile strength at continuous service temperatures that are substantially equal to or higher than 190° Celsius.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an elevational cross-sectional view of an embodiment of the lamp made in accordance with the teachings of the present invention;

FIG. 2 illustrates an enlarged cross-sectional view of a portion of the lamp with a fluoropolymer containment coating; and

FIG. 3 illustrates an enlarged cross-sectional view of a portion of the lamp with a silicone rubber containment coating

BEST MODE FOR CARRYING OUT THE INVENTION

For a better understanding of the present invention, together with other and further objects, advantages, and capabilities thereof, reference is made to the following disclosure and appended claims taken in conjunction with the above-described drawings.

As used herein, the term "light-source capsule" denotes: a tungsten-halogen incandescent capsule, an arc tube of an arc discharge lamp, or any light-emitting capsule within the outer envelope of a lamp wherein the light-source capsule operates a a pressure other than atmospheric and the possibility of minor shard dispersion upon fracture of the light source capsule exists. The light-source capsule may be either a single-ended or double-ended capsule.

The terms "contain" or "containment" as used herein mean that the containment means of the lamp, made in accordance wit the teachings of the present invention, is not pierced as a result of a fracture of the inner light-source capsule. Shard of the light-source capsule remain within the lamp and the containment means serves to prevent shard dispersion.

Referring now to the drawings with greater particularity, FIG. 1 shows an electric lamp 10 made in accordance with the teachings of the present invention. Electric lamp 10 include a light-transmissive outer envelope 12, containment means 13 disposed substantially over envelope 12 and a base 14.

Envelope 12, which may be formed of soda lime glass, has a body 15 and a neck 16. Lamp 10 further includes a light-source capsule 18 mounted within envelope 12 on a frame assembly 24. Light-source capsule 18, which may be formed of quartz or hard glass, has an envelope 20 and a press seal end 22. Envelope 12 has neck 16 running from ring 28 to brim 30. In addition, containment means 13 should overlap or be attached to a portion of base 14 to counteract the effects of gravity, by serving as a pouch or sack, in the event that envelope 12 breaks.

In one embodiment of electric lamp 10, body 15 of envelope 12 has a minimum wall thickness, x. Envelope 20 has a maximum wall thickness, y, of less than about 0.9 millimeter. In lamp 10, the ratio of x/y, which hereinafter will be referred to as the "wall-thickness ratio," is approximately equal to or greater than 3. When such a relationship exists, capsule 18 will be described herein as being "thin-walled" with respect to envelope 12, and conversely envelope 12 will be described as being "thick-walled" with respect to capsule 18. The prescribed range of the wall-thickness ratio insures that these comparative measures of "thick" and "thin" will be true by a factor of approximately 3 or greater.

The importance of the prescribed range of the wall-thickness ratio is as follows. When a thin-walled capsule fractures into shards, each shard is relatively thin and possesses less mass than would be the case if the capsule were not thin-walled. When these low-mass shards impact with the outer envelope, the impact energy per collision is reduced because energy is proportional to mass. The thinner shards tend to shatter themselves thereby dissipating collision energy harmlessly. There is evidence from observations that thin-walled capsules fracture into greater numbers of smaller shards than do capsules with greater wall thicknesses under similar operating conditions. The greater the number of shards

impacting with the outer envelope, the more the total energy o: the fracture will be spread uniformly over the outer envelope. The ultimate result of these factors is that the outer envelop has the ability to contain an inner capsule fracture when the wall-thickness ratio is within the prescribed range. Containment means 13 will preserve the integrity of the outer envelope of the lamp where the wall thickness ratio is not within the prescribed range.

In an alternative embodiment of the electric lamp, outer envelope 12 has a concave top 26 opposed to neck 16. the word "concave" means that the radius or radii of curvature of top 2 falls on the exterior of envelope 12. The concave shape of to 26 diverts shards and energy of a fracture of capsule 18 towar base 28 where they are least likely to cause damage; in so doing, top 26 shatters many shards which further dissipates fracture energy. Top 26 also reinforces the portion of envelope 12 that lies above capsule 18. This region of envelope 12 may require reinforcement for two reasons. First, top 26 may be the portion of envelope 12 closest to capsule 18. Second, there is the possibility that capsule 18 may fracture such that the upper portion of capsule 18, i.e., the portion of capsule 18 closer to top 26, may be propelled against top 26. This type of fracture may occur if envelope : of capsule 18 is fractured near press seal 22. If such a fracture should occur, the high pressure within capsule 18 ma: propel the portion of capsule 18 above press seal 22 toward t 26. It is believed that the region of capsule 18 where envelope 20 joins press seal 22 may be particularly susceptib to thermally induced fractures because of the substantial temperature gradient in this region caused by the high operating temperature of envelope 20 and the relatively cool operating temperature of press seal 22.

In another embodiment of the electric lamp, minimum wall thickness, z, of neck 16 is approximately equal to or greater than 2.5 millimeters. The extra thickness of neck 16 facilitates the mounting of frame-assembly 24 on neck 16 by means of elastic and frictional forces. For a detailed explanation of the means for mounting frame-assembly 24 with capsule 18 thereon within envelope 12, reference is made to co-pending United States Patent Application having Serial No. 469,841, filed February 25, 1983 and assigned to the present assignee.

Light source capsule 18 operates with fill pressures other than atmospheric, typically about 5 to about 20 atmospheres. At such pressures, and where the wall-thickness ratio is less than 3 (i.e., the outer envelope has a wall thickness similar to a standard incandescent bulb), a fracture of capsule 18 would result in a dispersion of shards from the capsule that would pierce the outer envelope where containment means 13 was absent from the exterior of the electric lamp. Containment means 13 (see FIG. 1) includes a coating, that is disposed over envelope 12 of lamp 10, for containing fragments resulting from fracture of capsule 18.

Containment coating 13 should be relatively transparent so as to allow a substantial amount of light to pass through it. In addition, coating 13 should be resistant to degradation by high temperature and ultraviolet radiation. According to the present invention, the containment coating material is preferably either a fluoropolymer or a silicone rubber base material. Coating 13 can be applied to an outer envelope of any wall thickness in order to provide containment capabilities. The coating materials used here also exhibit a high degree of tensile strength at high temperatures.

Referring now to FIG. 2, one embodiment of the fluoropolymer containment coating of the present invention is illustrated as coating 13A over a portion of envelope 12. In one specific use, coating 13A consisted of a perfluoroalkoxy resin i.e., P.F.A. Teflon material ("Teflon" being a trademark of E.I. du Pont de Nemours Co.). The visible light transmission of this coating was found to be about 99% of that of a clear outer envelope without such a coating. The perfluoroalkoxy resin material has a continuous service temperature rating of about 260° Celsius, and is essentially unaffected by ultraviolet radiation. Other fluoropolymer materials such as fluorinated ethylene-propylene copolymer (i.e., F.E.P. resin) and polychlorotrifluoroethylene (i.e., P.C.T.F.E. resin) also have similar containment capabilities and are unaffected by ultraviolet radiation, but do vary in service temperature rating. These materials have a service temperature of about 190° Celsius.

In an alternative embodiment of the fluoropolymer containment coating, the fluoropolymer coating could be applied in combination with a reinforcing material to provide either improved protection or to minimize the quantity of coating material required. One example of such a reinforcing material consists of using short glass fibers (less than 0.30 inch in length) mixed in suspension within the fluoropolymer material. This combination also has the advantage of providing inherent diffusion of the light emitted from lamp 10 where desired, due to the glass fibers. The thickness of the aforementioned fluoropolymer coatings are normally in the range of about 0.00 to 0.006 inch.

The fluoropolymer coatings of the present invention also provide lamp 10 with means for resisting thermal shock induced fracture, as might be caused by water droplets falling on the

lamp while it is in operation. In addition, the coating aids in making a "tamper-resistant" lamp by reinforcing the outer envelope to prevent breakage from rough handling or from a minor impact by an external force while the lamp is in operation. Manufacturing steps in making the lamp can be reduced by formulating a coating that can either diffuse the light emitted from the lamp (as in frosted or smoke white lamps) or be colored for decorative lamp purposes. The fluoropolymer coatings mentioned above can be applied by conventional techniques such as electrostatic powder coating, fluidized bed coating or wet spray coating.

Referring now to FIG. 3, one embodiment of the silicone rubber containment coating of the present invention is illustrated as coating 13B over a portion of outer envelope 12. The silicone rubber containment coating 13B comprises coating envelope 12 of lamp 10 with more than one layer of material. Two or more layers of material with differing moduli of elasticity are applied on envelope 12 of lamp 10. The combination of layers 13c and 13d, made of materials having high (13c) and low (13d) moduli of elasticity, provides a high degree of containment for lamp 10 due to the resistance of the multi-layer system to tear propagation. Each layer of transparent silicone rubber is formulated to have a different modulus of elasticity. Each layer is applied by the process of dip coating. The thickness of each layer is in the range of about 0.001 to 0.003 inch. The overall thickness of the silicone rubber coating is in the range of about 0.002 to 0.006 inch. The silicone rubber containment coating 13B will also provide containment capabilities for a lamp having the wall thickness of a standard incandescent light bulb.

Examples

In accordance with one embodiment of the present invention, the exterior of an A-19 bulb, containing a T-4 size tungsten-halogen capsule, made of aluminosilicate or hard glass material, at about 10 atmospheres pressure, was coated with a 0.005 inch thick coating of perfluoroalkoxy resin. The coating reliably contained the glass fragments of the purposely fractured T-4 size halogen capsule. Visible light transmission of this coating was found to be about 99% of that of a lamp with a clear envelope or bulb. The perfluroalkoxy resin had a continuous service temperature rating of about 260° Celsius.

In accordance with another embodiment of the present invention, an outer envelope of the lamp was formed from soda-lime glass with a concave top. The envelope had a minimum wall thickness of about 1.9 millimeters. The T-4 size tungsten-halogen capsule within the lamp, which was made of aluminosilicate glass, was at 10 atmospheres pressure and had a volume of about two cubic centimeters. The perfluroalkoxy resin coating on the outer envelope was about 0.001 inch in thickness. The coating here reliably contained the glass fragments of the purposely fractured halogen capsule.

In accordance with still another embodiment of the present invention, an A-19 bulb containing a T-4 size tungsten-halogen capsule at about 10 atmospheres pressure was coated with an overall 0.006 inch thick layer of silicone rubber material. The coating was comprised of two layers of silicone rubber material, each layer having a differing moduli of elasticity. One layer had a high modulus of elasticity and the other had a low modulus of elasticity. The layers were applied by the process of dip coating. The coating here reliably contained the glass fragments of the purposely fractured halogen capsule.

Thus, there has been shown and described an improved containment means for containing fragments of glass within a lamp resulting from the fracture of a light source capsule within the lamp. The containment means consists of a coating of either a fluoropolymer material or a silicone rubber material that is disposed over the outer envelope of the lamp and is of a substantially light-transmissive material. The coatings also exhibit a high degree of tensile strength at high temperatures. The coating should be resistant to high temperatures (about 190° Celsius or higher) and be unaffected by ultraviolet radiation.

While there have been shown what are at present considered to be the preferred embodiments of the invention, it will be apparent to those skilled in the art that various changes and modifications can be made herein without departing from the scope of the invention as defined in the appended claims.

CLAIMS

WHAT IS CLAIMED IS:

1. An electric lamp comprising:

a light-transmitting envelope:

a pressurized light-source capsule mounted within said envelope; and

containment means for containing within said lamp fragments of glass resulting from fracture of said capsule, said containment means disposed substantially over said envelope and being of a substantially light transmissive material, said containment means having a high degree of tensile strength at continuous service temperatures that are substantially equal to or higher than 190° Celsius.

2. The electric lamp according to Claim 1 wherein said containment means further provides said lamp with means for resisting thermal shock induced fracture.

3. The electric lamp according to Claim 2 wherein said containment means is substantially unaffected by ultraviolet radiation.

4. The electric lamp according to Claim 3 wherein said containment means includes a fluoropolymer material coating.

5. The electric lamp according to Claim 3 wherein said containment means includes a silicone rubber material coating comprising a plurality of layers having differing moduli of elasticity.

6. The electric lamp according to Claim 4 wherein said fluoropolymer material is a perfluoroalkoxy resin.

7. The electric lamp according to Claim 6 wherein said perfluoroalkoxy resin coating has a thickness in the range of about 0.001 inch to about 0.005 inch.

8. The electric lamp according to Claim 4 wherein said fluoropolymer material is a fluorinated ethylene-propylene copolymer resin.

9. The electric lamp according to Claim 4 wherein said fluoropolymer material is a polychlorotrifluoroethylene resin.

10. The electric lamp according to Claim 4 wherein said containment means further includes a reinforcing material, said reinforcing material being short glass fibers in suspension within said fluoropolymer coating.

11. The electric lamp according to Claim 10 wherein said short glass fibers have a length less than about 0.030 inch.

12. The electric lamp according to Claim 5 wherein said plurality of layers includes at least a layer of high modulus material and a layer of low modulus material, said layers of high and low moduli being adjacent to one another.

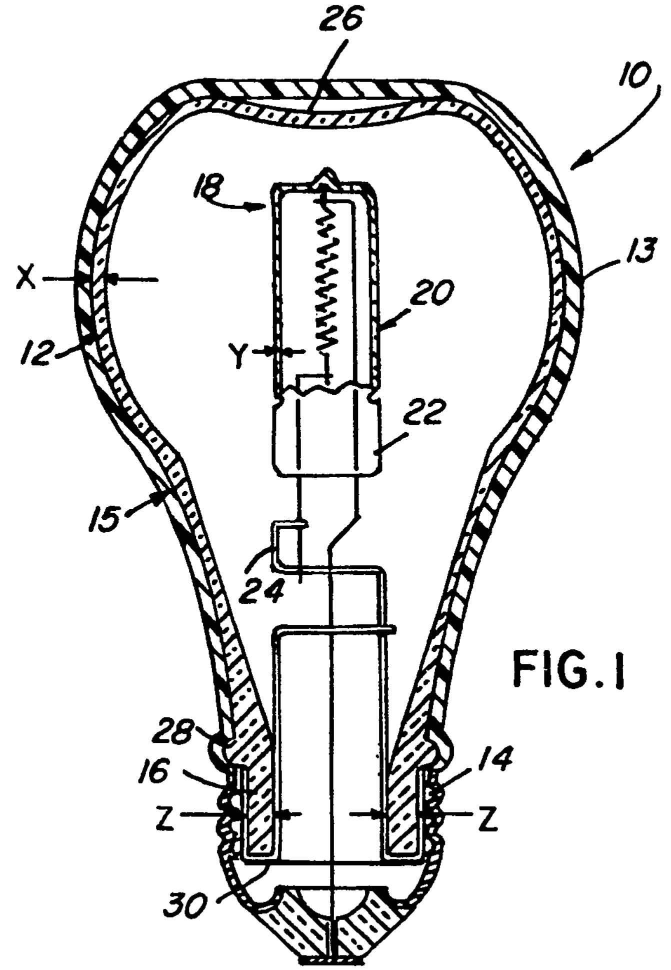

FIG. 1

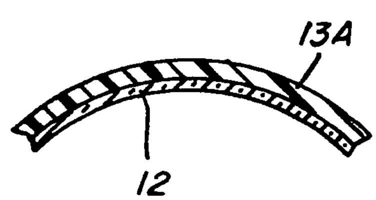

FIG. 2

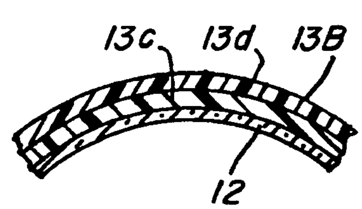

FIG. 3